Static and Dynamical Characteristics of Semiconductor Vertical-Emitting Lasers with Incorporated Photonic Crystals

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1. INTRODUCTION

In semiconductor Vertical-Cavity Surface-Emitting Lasers (VCSELs) single-mode output is desirable for many applications. In this work we experimentally and theoretically investigate the incorporation of two-dimensional photonic crystal (PC) waveguides into the top of the distributed Bragg reflectors fabricated using focused ion beam etching (FIBE).. This is done to control the transverse optical modes in the cavity and also is seen to improve the modulation characteristics.. Results for VCSELs with PC are compared to VCSELs without the PC and with VCSELs with micropillar microcavities.

Results

AlGaAs/GaAs 850nm emitting multimode VCSELs from Optowell Co., Ltd were etched with the FEI200 focused ion beam system. Fig. 1.shows the top view of a VCSEL with the PC. The PC shown in the picture has holes with the diameter of 2 μm, the spacing between centers of the holes is 4 μm, and the hole depth is about 3.2 μm. VCSELs with different PC depths, hole diameters and hole-to-hole spacing were experimentally investigated in the work. Power versus current, spectral and small-signal modulation characteristics of VCSELs with PCs were measured. Fig. 2 shows spectral characteristics of the VCSEL shown in Fig. 1.

2. CONCLUSION

VCSELs with PCs in their top Bragg reflector are experimentally investigated. The PC allowed to establish current and thermally independent single transverse and single-frequency radiation from VCSELs. Experimental results had were shown that that different optimizations of the PC geometry are required for single-mode emission and improved speed properties of VCSELs.

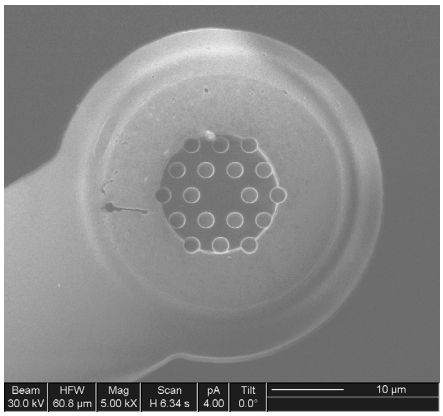

Fig. 1. FIB picture of the VCSEL with the PC.

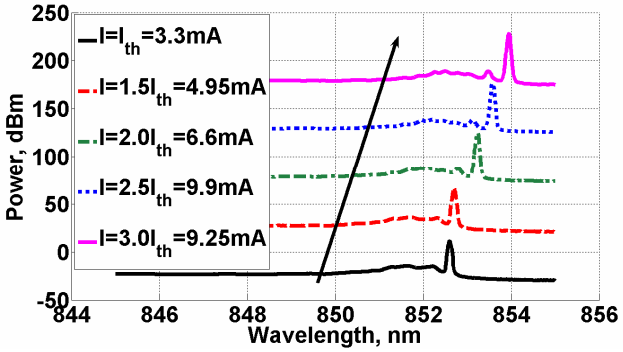

Fig. 2. VCSEL emission spectrum versus injected current.